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PRINTED CIRCUIT BOARD (PCB) DESIGN FOR IOT DEVICES

Introduction

Printed Circuit Board (PCB) design and manufacturing can be broken down into two steps: Schematic and layout design using software and then hardware manufacturing. Software and hardware choices for individual PCBs vary based on the application. The onset of the Internet of Things (IoT) has brought about a need to make things smaller, smarter, and more versatile in physical form. This requires moving away from traditional layout techniques and materials used to build PCBs. Not only must a PCB mechanically support multiple electronic components as substrates, but it also electronically connects them through conductive paths to achieve specific functions as designed [1]. This paper reviews the options available today and considerations that need to be taken when building a modern-day PCB.

Commented [TMJ1]: requirements

Commented [TMJ2]: (an incentive?) to minimize the device's physical footprint

Commented [TMJ3]: must (if you use previous revision)

Commented [TMJ4]: See above

Commented [TMJ5]: The current tools, processes, and conderations

Commercial Software tools

There are many software tools available mainly varying in capability and cost. Users make their choice based on budget and required features. The most important aspect of the software is that it accurately represents the circuit's schematic and maps it to the correct physical space during layout.

Commented [TMJ6]: The most important aspect of the software is that it accurately represents the circuit's schematic (and maps this to a physical space?).

Freeware

Commented [TMJ7]: https://www.maketecheasier.com/free-software-vs-open-source-vs-freeware/

Free software is widely used among hobbyists and for small scale projects at the university level. The most popular being Eagle, Kicad, and DesignSpark PCB [2]. Free software tools generally have limitations on design complexity (number of layers, components, and board size). Some tools like Eagle are free to start using for simple designs, but can be upgraded to professional versions as needed for a fee (see premium). This allows addition of complexities to existing designs.

Commented [TMJ8]: Software packages are

Premium

The domain of paid for software tools offers a wide selection of features. These are used by professionals, generally with more complex requirements such as auto routing and suggestive feedback during design. Most popular tools are cadence's Alegro, PADS, and Altium. They vary drastically in cost and can be purchased in a per feature option too. To get an idea, the approximate base costs of Allegro is $25,000 (plus yearly upgrade fee), PADS is $15000, Altium is $5000 and Eagle Pro is $1500 [3]. These advanced tools also offer simulation capabilities which can eliminate thermal issues and other design problems early on during the design phase.

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Commented [TMJ10]: Thermal what?

Manufacturing Technology and Considerations:

Once schematics and layouts are drawn up in software, the physical PCBs can be produced.

Heat and Power

As devices get smaller heat generated by components becomes more localized. This results in "Hot Spots" on the PCB, localized areas with a significant temperature gradient [4]. Active control for heat dissipation paths must be carefully assessed to ensure the effectiveness and integrity of components remain unaltered. Thermal and power management are critical to aging and life cycle length [5]. Techniques like high-density PCB's, ball grid array chips, and efficiency-based design are made available using buried/blind vias (electrical connections between layers) and microvias (0.006 inches or less in diameter) [4]. Smaller vias and thinner traces reduce the number of layers needed further reducing the cost as well.

Form factor

A sizable portion of IOT devices are in the wearables category. These devices need to be able to flex and bend to dynamic surfaces like skin [6]. Bendable PCBs are made from flexible dielectric material (polymide) embedded with metal traces to allow for conductive paths [7]. Non-flexible or firm PCBs are made with glass epoxy FR4 and conductive metal traces (usually copper) [6]. A combination of traditional firm PCBs and flexible PCBs are used to allow for various levels of versatility at the expense of reduced layers and multi segment solutions.

Simulation

Simulations are done before (only with schematics) and after board layout, with different purposes, but the goal remains the same—to drive design changes. In both, physical parameters are translated into circuit elements and other mathematical models for visualization. The main purpose of pre-layout simulation is to develop design constraints while that of post layout simulation is used to verify these design constraints [8]. Obtaining a clear picture and enough information about the interactions of the various physical mechanisms is crucial for the time to market and quality of the products [9]. Improved accuracy and reduced need for re-work is key.

Commented [TMJ11]: As devices get smaller, the heat generated by the device becomes more localized.

Commented [TMJ12]: This results in "Hot Spots" on the PCB, localized areas with significant temperature variation.

Commented [TMJ13]: ensure

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Commented [TMJ15]: (design implementations or systems?) are critical to device aging and life cycle length

Commented [TMJ16]: Do you need to describe what a via is?

Commented [TMJ17]: A significant percentage of current IOT devices are in the wearables category. These devices need to be able to flex and bend to dynamic surfaces like skin.
(NOTE: this may require a quick source)

Commented [DA18]:

Commented [TMJ19]: Performed with the schematic and also with the board layout

References

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